UT-BATTELLE

# Self-assembled Nanoclusters in Oxide-dispersion-strengthened Steel


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**Supported by DOE, Basic Energy Sciences**

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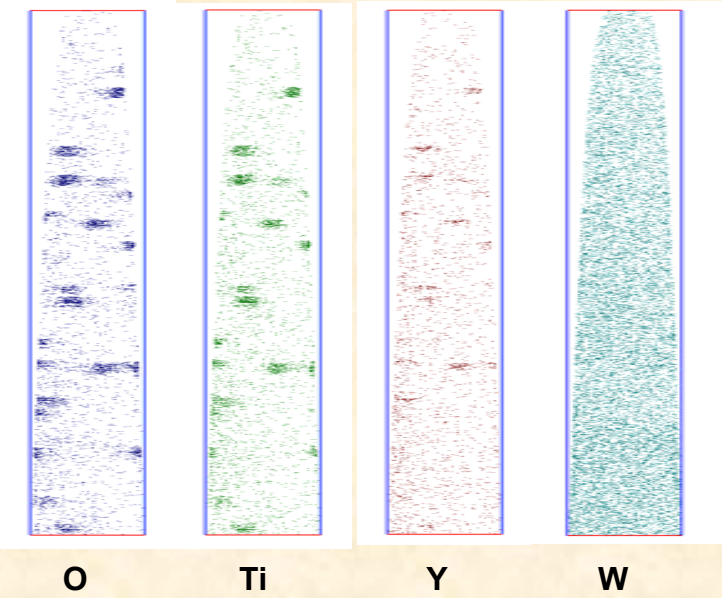
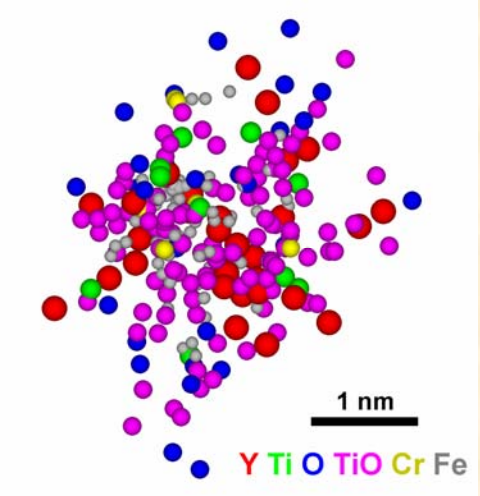
U. S. DEPARTMENT OF ENERGY

# ODS Steel Containing Y-Ti-O Nanoclusters Exhibits Outstanding Mechanical Properties at High Temperature

- **Creep rate is reduced by six orders of magnitude in ODS steel containing Y-Ti-O**

Atom probe showed that Y-Ti-O form nanoscale clusters that are highly stable even at high temperatures

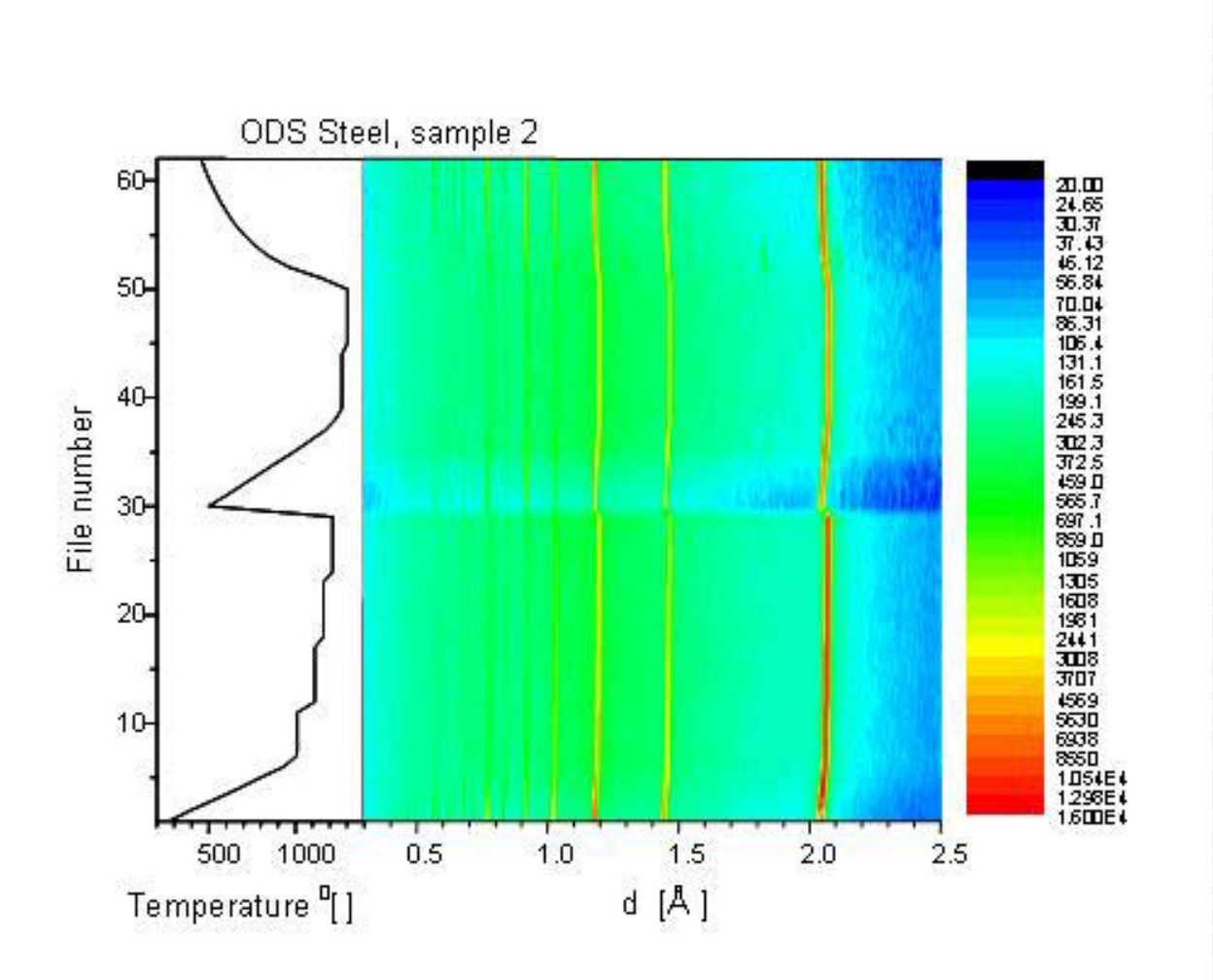


# Key Questions for neutron scattering studies

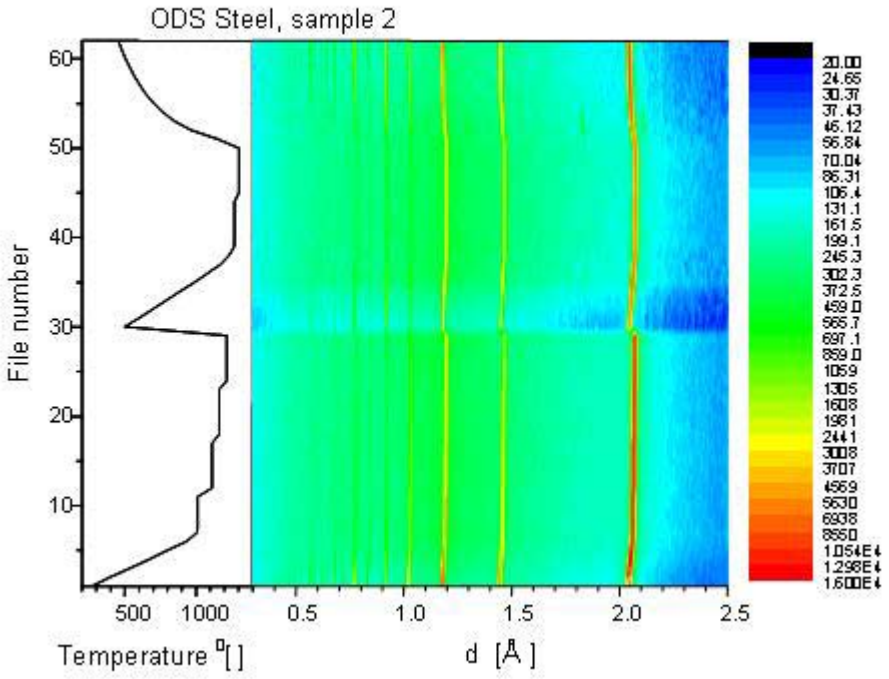
- Structure of the nanocluster
- Thermal stability

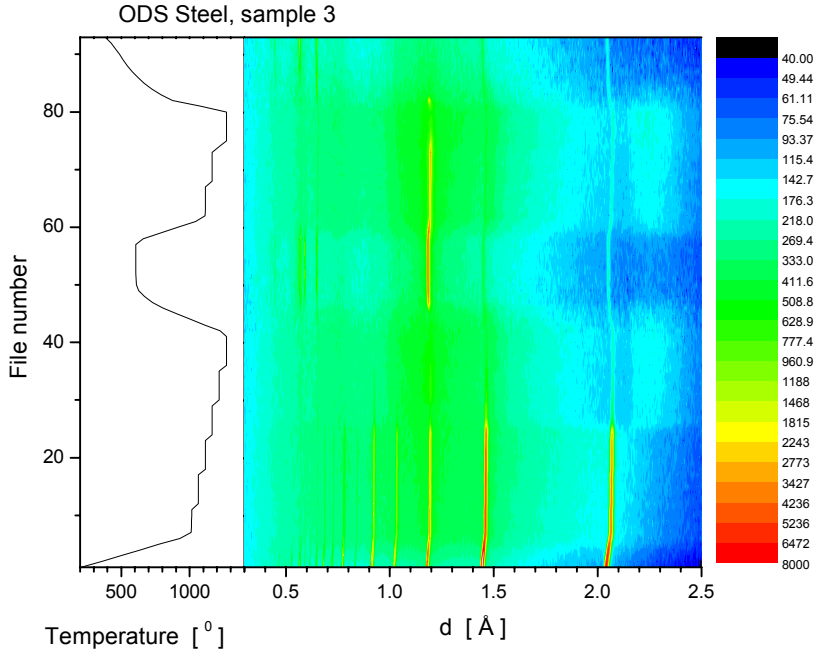
# Y-Ti-O Containing Steel Is Highly Stable Even at 1250 C




Exp. done at IPNS, with J. Richardson

# Samples Prepared by A Different Method Shows a Transition at 1250 C




**Diffraction peaks disappear at 1250 C**

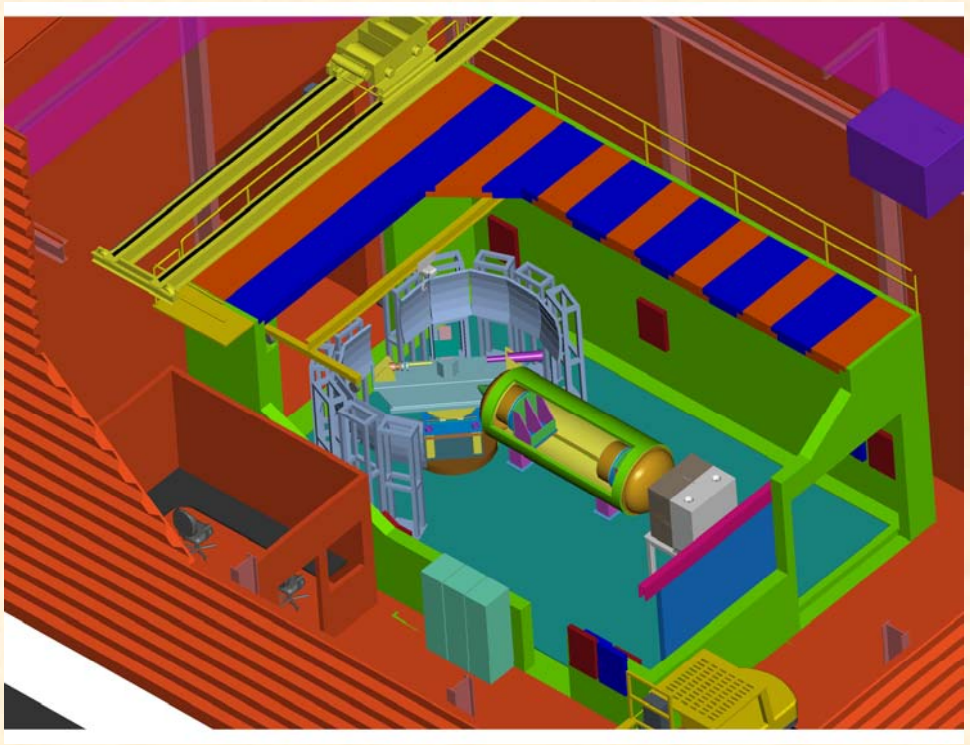
# In-situ Small Angle Scattering Work Are Underway

- To study the themal stability of the nano clusters
  - Challenges: Furnaces that can go above 1300 C

- It would be nice to do both diffraction and small angle scattering at the same time
  - Several SNS instruments are designed with this need in mind

# My Dream Experiment

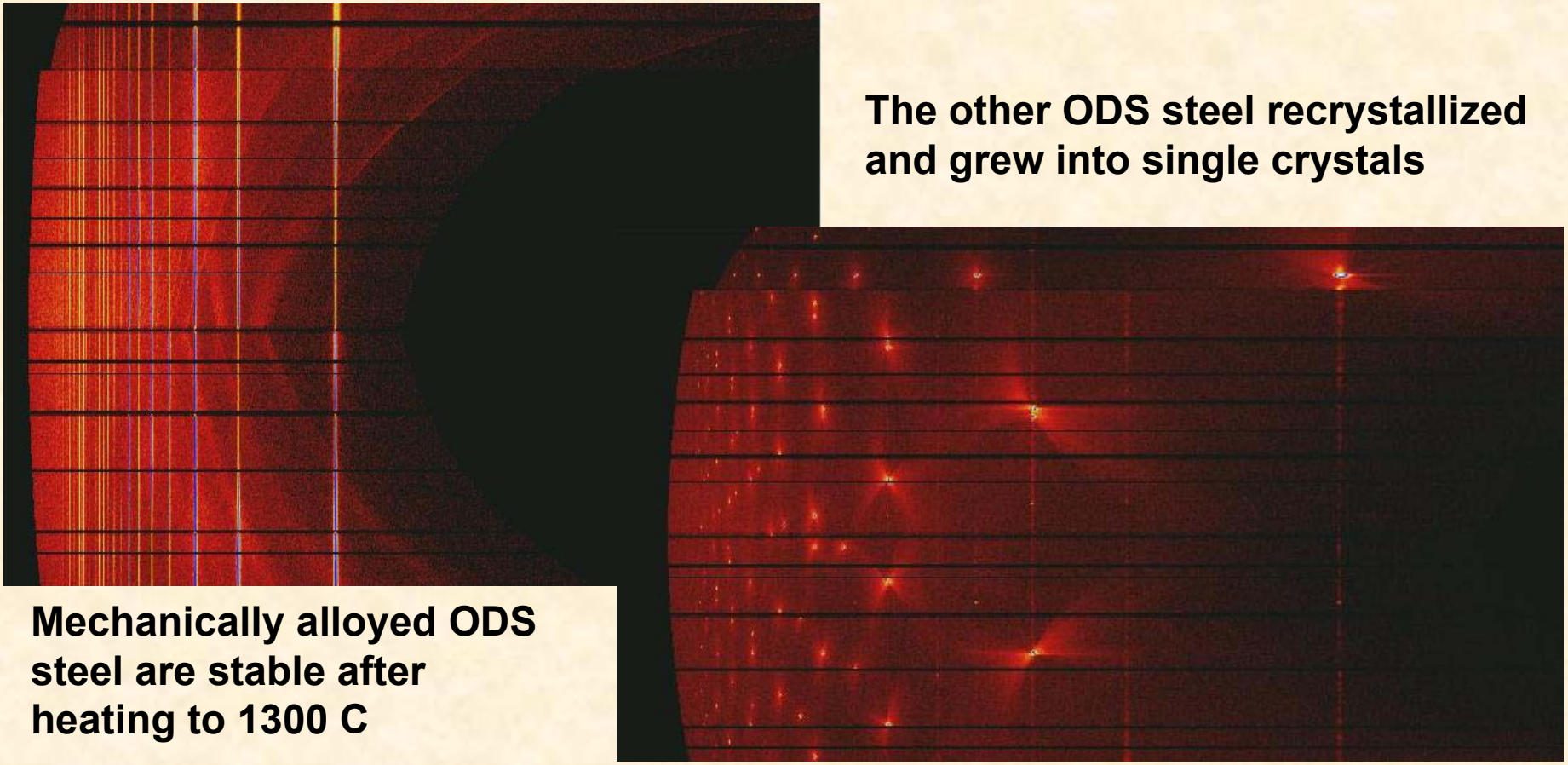
- Measurements of scattering data over multiple or continuous Q-range
  - To study the multi length scale phenomena (e.g., phase transformation)
  - Time-resolved
- Simultaneous characterization capabilities
  - DSC
  - Dilatometry
  - Transport properties
- A variety of sample environments
  - Temperature
  - Applied load
  - Electric or magnetic fields



The VULCAN diffractometer is designed with these needs in mind

# In-situ Neutron Diffraction Studies to 1300 C Demonstrated the Thermal Stability of Mechanically-Alloyed ODS Steel

**Room temperature diffraction patterns after heating to 1300 C**



**The other ODS steel recrystallized and grew into single crystals**

**Mechanically alloyed ODS steel are stable after heating to 1300 C**